

SECTION 104 - STRUCTURAL STEEL

1. GENERAL

This specification covers carbon steel shapes, plates, and bars of structural quality for use in welded construction of bridges and for general structural purposes. The welding procedure shall be suitable for the steel and the intended service.

This work shall include all structural steel used in structures, fabricated and constructed in accordance with the specifications in conformity with the lines, grades, dimensions, and design shown on the plans or established by the Engineer.

2. SHOP REQUIREMENTS

All steel furnished under this specification shall conform to the requirements for "Structural Steel," A.S.T.M. Designation A36. The manufacturer shall submit to the Engineer 3 copies of a certified mill test report covering the chemical and physical properties and process of manufacture of each heat number of metal included in the shipment.

A. Shop Drawings. Before any fabrication is begun under the contract, the Contractor or fabricator shall submit to the Engineer for approval prints of shop drawings of structural steel. These prints shall be submitted in duplicate for checking and 6 copies shall be submitted for final approval and distribution unless more copies are requested.

Changes on approved drawings or plans shall be subject to the approval of the Engineer, and he shall be supplied with a record of such changes.

Substitutions of sections different from those shown on the drawings shall be made only when approved in writing by the Engineer.

The Contractor shall be responsible for the correctness of his drawings, and for shop fits and field connections, although the drawings may have been approved by the Engineer.

Any material ordered or work done by the Contractor before the shop drawings have been approved shall be at his own risk.

B. Rejection. The acceptance of any material of finished members by the Inspector shall not be a bar to their subsequent rejection, if found defective. Rejected material and workmanship shall be replaced promptly or made good by the Contractor.

C. Handling Materials. The loading, transportation, unloading, and storing of structural steel shall be conducted so that the metal will be kept clean, above ground, and free from injury.

3. FABRICATION.

A. Quality of Workmanship. Workmanship and finish shall be equal to the best general practice in modern fabrication shops.

B. Storage of Materials. Structural steel, either plain or fabricated, shall be stored above ground upon platforms, skids, or other supports. It shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion.

C. Straightening Materials. Rolled material, before being laid off or worked, must be straight. If straightening is necessary, it shall be done by methods that will not injure the metal. Sharp kinks and bends shall be cause for rejection of the material.

D. Finish. All work shall be finished neatly. Shearing and chipping shall be done carefully and accurately. Finished members shall be true to line and detailed dimension. They shall be free from twists, bends, and open joints or other defects.

E. Fit of Stiffeners. Bearing stiffeners and stiffeners intended as supports for concentrated loads shall be milled, ground, or machine cut to secure full bearing against the flanges. Intermediate stiffeners shall fit with a uniform distance from the flange plates.

F. Finished Members. Finished members shall be true to line and detail dimension. They shall be free of twists, bends, and other defects or flaws from any cause.

G. Shop Subassembly. In addition to the provisions of 503, "Assembly" of the American Welding Society Specifications, surfaces of metal to be placed in contact shall be cleaned and dressed to a smooth surface before welding.

The parts of a member shall be assembled and tack-welded along contact surfaces. Tack welds that are to be incorporated in the final welds shall be subject to the same quality requirements as the final weld. Defective cracked or broken tack welds shall be removed before the final welding.

H. Shop Final Assembly. For field weld connections, each line of beams or each line of girders shall be laid out and supported on both flange edges to proper line and camber. The fabricator shall have all field connections double beveled and with the proper space between abutting flanges of all girders and beams for final assembly.

In making the final assembly, if recutting is necessary, to form a uniform width opening for both flanges and/or web, the butt point shall be finished by precision flame cutting or flame cutting and grinding that will produce the same smoothness as the precision cut. Mechanical chipping will not be permitted.

Erection angles shall be fitted, drilled and/or reamed and bolted into place while the beams or girders are fit-up, in such workmanlike manner that standard drift pins can be driven through any combination of holes and the beams or girders be pulled to correct spacing for field welding when erected at the bridge location. Slotted holes in the out-stand leg of the erection angles are not required.

4. SHOP PAINTING

Unless otherwise indicated on the plans, all structural steel shall receive 1 coat of

basic lead silico chromate paint in the shop. When the plans provide for the shop paint to be applied in the field, it shall be applied in accordance with these requirements for shop painting. When fabrication is completed and accepted, surfaces not painted before assembling, except surfaces to be in contact after erection, shall be painted with 1 shop coat. All metal surfaces within 2 inches of field welds shall not receive the shop coat until after field welding is completed. The minimum wet film thickness of the shop coat shall be 2-1/2 mils. The paint shall be applied so that it does not run, sag, crawl, or have other defects. Material shall not be loaded for shipment until the paint is dry.

All metal surfaces to be painted shall be cleaned in conformance with Steel Structures Painting Council Surface Preparation Specifications, No. 6, Commercial Blast Cleaning (SSPC-SP 6-63) or latest revision, except that wet blasting will not be permitted. Cleaned surfaces shall be covered completely with the initial coat of paint within 8 hours after cleaning or the steel shall be recleaned immediately prior to painting. All paint damaged by cleaning, gas cutting, or welding shall be removed and the surface shall be repainted.

Paint shall be thoroughly mixed before applying, and the pigments shall be kept in suspension.

Paint shall not be applied when the air temperature is below 40 degrees F., when the air is misty, or when, in the opinion of the Engineer, conditions are otherwise unsatisfactory for the work. It shall not be applied upon damp or frosted surfaces.

Material painted under cover in damp or cold weather shall remain under cover until dry or until weather conditions permit its exposure in the open. Painting shall not be done when the metal is hot enough to cause the paint to blister and produce a porous paint film.

Painting shall be done in a neat and workmanlike manner, using brushes, rollers, or a pneumatic spray. If applied with a pneumatic spray, the paint shall be brushed out where necessary and the workmanship shall be equal to that obtained by first-class brush work. The use of round or oval brushes is preferred, and flat brushes exceeding 4 inches in width will not be permitted. On surfaces which are accessible to paint brushes, the paint shall be applied with sheepskin daubers especially constructed for the purpose.

The paint when applied shall be so manipulated as to produce a uniform even coating in close contact with the metal or with previously applied paint and shall be worked into all corners and crevices.

If the painting is unsatisfactory to the Engineer, the paint shall be removed and the metal thoroughly cleaned and repainted.

If it is necessary in cool weather to thin the paint on account of congealing, this shall be done only by heating in hot water or on steam radiators, and liquid shall not be added nor removed unless permitted by the Engineer.

Surfaces not in contact but which will be inaccessible after assembling or erection shall be painted 2 coats.

No paint shall be applied over erection marks until after erection.

5. FIELD REQUIREMENTS.

A. Erection. The Contractor shall erect the metal work, remove the temporary construction, and do all work required to complete the structure as covered by the contract, all in accordance with the plans and specifications.

The erector shall furnish detail plans for the structure to be erected, including shop details, camber diagrams, and copy of shipping statements showing a list of parts and their weights.

The Contractor shall provide all falsework, tools, machinery and appliances, including drift pins and fitting-up bolts, necessary for the expeditious handling of the work and upon completion of the erection shall remove same together with all other obstructions or debris resulting from his operations.

Material and workmanship not previously inspected will be inspected after delivery to the site of the work. Material to be stored shall be placed on skids above the ground. It shall be kept clean and properly drained. Girders and beams shall be placed upright and stored. Long members, such as columns and chords, shall be supported on skids placed near enough together to prevent injury from deflection.

The falsework shall be properly designed and substantially constructed and maintained for the loads which will come upon it. The Contractor, if required, shall prepare and submit plans of the falsework to the Engineer for approval. Approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility.

Before starting work, the Contractor shall inform the Engineer fully as to the method of erection he proposes to follow, and the amount and character of equipment he proposes to use, which shall be subject to the approval of the Engineer. The approval of the Engineer shall not be considered as relieving the Contractor of the responsibility for the safety of his method or equipment or from carrying out the work in full accordance with the plans and specifications.

Masonry bearing plates shall not be placed upon beam bearing areas which are improperly finished, deformed or irregular. Bearing plates shall be set level in exact position and shall have a full and even bearing upon the masonry. Unless otherwise indicated on the plans or directed by the Engineer, they shall be placed on mats or pads made by either of the following methods:

1. Canvas and Red Lead: Thoroughly swab the beam bearing area with red lead paint and place upon it 3 layers of 12 to 14 ounce duck, each layer being thoroughly swabbed on its top surface with red lead paint. Place the beams in position while the paint is plastic.

2. Preformed Fabric Pad: This pad shall consist of a single 1/8-inch sheet of rubber impregnated cotton duck using 8-ounce duck

and high quality natural rubber in 7 plies.

The cotton duck shall have 2-ply warp and filling yarn and 40 threads per inch fill, 50 threads per inch warp. The breakdown stress for compression perpendicular to the plane of lamination shall be not less than 11,000 p.s.i. A tolerance on thickness of plus or minus 5% will be permitted.

The anchor bolts shall be set as directed by the Engineer, and preferably, if construction conditions permit, by first setting the bearing devices and superstructure and then drilling holes for the anchor bolts. They shall be set accurately and fixed with nonshrink grout completely filling the holes. Grout shall be prepared using Embeco as manufactured by Master Builders Company, Cleveland, Ohio, or a product approved by the Engineer. The location of the anchor bolts in relation to the slotted holes in the beams shall be varied with the prevailing temperature. The nuts on anchor bolts at the expansion ends of spans shall be adjusted to permit the free movement of the span and lock nuts shall be provided.

No member slightly bent or twisted shall be put in place until its defects are corrected, and members seriously damaged in handling shall be rejected. The straightening of plates and angles or other shapes shall be done by methods which will not produce fracture or other injury. The metal shall not be heated unless permitted by the Engineer, in which case the straightening shall be at a temperature no higher than 1,000 degrees F. as determined by a Temple Stick or equivalent. After heating, the metal shall be allowed to cool as slowly as possible.

Following the straightening of a bend or buckle, the surface of the metal shall be carefully inspected for evidence of fracture.

The parts shall be accurately assembled as shown on the plans and erection diagrams and the match marks shall be followed. The material shall be carefully handled so that no parts will be bent, broken, or otherwise damaged. Hammering which will injure or distort the members shall not be done. Bearing surfaces and surfaces to be in permanent contact shall be cleaned before the members are assembled.

B. Field Welding. The welding procedure and sequence of welding shall be shown on the shop detail sheets and submitted to the Engineer for approval. The approved procedure and sequence shall govern all field welding.

The following procedures and sequences apply to the welding of all field splices:

Align the butt joints so that the final opening of the flange shall be not less than 1/8" nor more than 3/16".

Tack weld the flanges on both sides of the extension bars.

Weld the first series of passes on the same side in the top and bottom flanges. (Weld passes shall begin or terminate on the extension bars.)

Arc-air the roots of the first pass in each flange to sound metal. Note: Gouging shall be done with arc-air method or it may be done by flame gouging when the operator is able to perform such a method to the satisfaction of the Engineer. Mechanical chipper may be used to remove slag only. Weld the next series of passes in the gouged area.

Continue welding the bottom and top of each flange, alternating the passes to offset shrinkage and warping.

When sufficient deposited metal has been added to the top and bottom flange butt splice (not less than the equivalent of half the flange thickness), the operator shall begin the welding of one side of the web splice. All web passes shall be vertical uphill, using a step back sequence method. The passes shall be cascaded near the erection angles. Remove the erection angles and complete the web splice on the same side.

After the web splice is completed on one side, the flange welds shall be completed. After the flange welds are completed, back gouge the web first pass, then complete the web splice using the step back method, welding uphill on all passes.

After the erection angles have been removed, the bolt holes in the web shall be filled with steel punching seal welded. The seal webbing shall be accomplished without dragging the arc from the web into the weld area.

When required, reinforcing shall be carefully removed so that the grinding wheel marks will be parallel to the web of the girder.

Nondestructive tests, when required, shall be completed and repairs made before the final approval of the butt joint.

Remove the extension bars from the flanges by careful flame cutting and grind to a uniform surface flush with the edges of the flanges.

All low hydrogen type electrodes shall be dried at 250 degrees F. minimum for 24 hours (500 degrees F. for 4 hours) before using. Exposed electrodes that are unused after 4 hours shall be returned to the drying oven. Electrodes may be stored immediately after drying in a storage oven held at a minimum temperature of 250 degrees F.

All slag, spatter, rough or excess reinforcing shall be removed by grinding. Weld areas shall be sandblasted.

Low hydrogen type electrodes shall conform to the AWS E7016, E7018, E6016, or E6018 classifications.

When the member is a wide flange section, the welding sequence shall be a flange, then to the web between erection angles and then to the other flange. The web welds shall be cascaded until half the thickness has been filled with deposited metal. The back side of the first welded passes shall be arc-air gouged to sound metal. All

other requirements outlined above and applicable to wide flange sections will apply.

C. Field Painting. The general requirements for paints, their mixing and application, weather conditions, cleaning of surfaces to be painted, and the quality of workmanship, as specified for shop painting shall apply to field painting.

The Contractor shall protect all portions of the concrete surfaces against damage or disfigurement by spatters, splashes, smirches, and spray of paint materials.

Unless otherwise specified on the plans, field painting shall consist of 2 coats applied after erection.

Unless otherwise indicated on the plans, field painting shall be as follows: Basic lead silico chromate maroon paint shall be used for the first field coat on structural steel. The minimum wet film thickness of the first field coat shall be 2-1/2 mils. Basic lead silico chromate dark green paint shall be used for the final field coat. The minimum wet film thickness for the final field coat shall be 2-1/2 mils. Each coat shall be applied so that it does not run, sag, crawl, or have other defects.

As soon as the field cleaning has been done to the satisfaction of the Engineer, any accessible surfaces from which the shop coat of paint has been omitted or worn off or become otherwise defective, shall be covered with 1 coat of the same paint as was used for the shop coat. Renewal of the shop coat will not be required on any surface or part of structural steel which will be embedded in concrete in the finished structure.

When the paint applied for touching up abraded surfaces has become dry, the first field coat shall be applied. In no case shall a coat be applied until the previous coat has dried throughout the full thickness of the finished paint film.

Small cracks and cavities which have not been sealed in a watertight manner by the first field coat shall be filled with a pasty mixture of red lead and vehicle before the second field coat is applied. The second field coat shall not be applied to any steel below the roof until the concrete roof has been placed.

Any metal coated with impure or unauthorized paint shall be thoroughly cleaned and repainted to the satisfaction of the Engineer, at the expense of the Contractor.